**Lab Assignment 2. Programming a CR1000. 20 points**

**Objective**: Become familiar with wiring a temperature/relative humidity sensor to the CR1000, programming the logger to obtain data from the sensor, and modifying the program to indicate when an environmental condition is met.

**Before the Lab Session**

* 1. You must complete the preliminary assignment for Lab 2 by 10 AM January 23.
	2. **Read through the entire assignment so that you understand what is being required. Ask questions, if things don’t make sense. You need to complete through STEP 5 in the lab. If you run out of time, then arrange with a TA to continue after class or at another time.**
	3. Review the information on temperature and humidity sensors in the text.
	4. Read through the brochure about the CS215 temperature and relative humidity sensor available from:. <http://www.campbellsci.com/documents/product-brochures/b_cs215.pdf>. SDI-12 comms is a protocol that allows many sensors to use the same control port, making it possible to have a large number of sensors controlled by a single CR1000.

You will complete the following questions as part of the lab report, not as part of the preliminary lab assignment. But, now is a good time to collect the required information.

* 1. *Question 1.* Much of that content may not make a lot of sense. The CS215 uses a single chip for both the temperature and RH sensor (the Sensirion SHT75- google that). Undergrads: how does the Sensirion measure temperature and relative humidity? (Graduate students only). Read the datasheet on the Sensirion sensor and describe in a paragraph or two briefly how it works.
	2. *Question 2.* But there are some basic nuggets of info that you need to recognize in the documentation. Based on the manufacturer’s information complete the following:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Temp Accuracy 5C to 40C | Temp Accuracy -40 to 70C | Temp Response time(sec) | RH Accuracy 10-90% | RH Accuracy 0-100% | RH Response Time (sec) |
|  |  |  |  |  |  |

* 1. *Question 3.* How long does it take for the temperature sensor to increase by 0.95C when the environment experiences a 1C step temperature increase? Hint: go back to the info on time response from the first lab. What impact might the relatively slow time response of this sensor have on estimating the daily minimum or maximum temperature?
	2. *Question 4*. What is the pore size of the cover in microns? How does that compare to the size of small particulates associated with air pollution that we often worry about? Will those small particles make it through the cover?
1. **Equipment List. You will check out, be responsible for, and return the following:**
	1. PS100 power supply
	2. CS1000 datalogger
	3. USB- 9 pin serial cable
	4. CR1000KD keypad display and cable
	5. CS215 temp/rh probe
	6. LED
	7. Straight screwdriver
2. **Setting up the Logger**
	1. Create a folder on the netbook Desktop using your last names: e.g., HOREL\_ANDER\_LUCKE
	2. Click on LoggerNet and select “Setup” from the “Main” menu. You should be in the EZ View. If you see a CR1000, click on the CR1000 and select Delete.
	3. Add a CR1000 data logger. You should see DataLogger Name “CR1000”.
	4. Select “Direct Connect” Connection Type. Be sure the serial cable is connected from the netbook to the RS-232 port on the logger. Select from the pull down menu the serial port, e.g., “COM3”. If you don’t see one, STOP, and ask for some help.
	5. Leave Datalogger settings alone. Test Communications. If you do not get to the DataLogger Clock option, then something is haywire and STOP and ask for help. If everything is working, don’t send program, select Finish.
3. **Creating a Program and Sending it to the Datalogger**
	1. Step 1. Select New Program
		1. Datalogger model (CR1000)
		2. Scan interval (15 sec)
	2. Step 2. Sensors
		1. Leave Default measurement of battery voltage (BattV)
		2. Add from sensors- meteorological- Relative Humidity and Temperature. Click red arrow and should have on right side: AirTC and RH
		3. Follow instructions from wiring diagram
	3. Step 3. Output
		1. Store every 15 seconds for Table 1. Rename Table 1 to be CS215. Remove Table 2.
		2. Select sample for airTC and for RH
		3. Save program to your Team’s Desktop folder. YourName\_Lab2. Do not send the program to the Datalogger yet
	4. Step 4. Exit out of Short Cut and select the CRBasic Editor from the Program Menu
		1. Open your program
		2. There are three parts
			1. Declare variables and units
			2. Define Data Tables
			3. Main Program
		3. An initial quote indicates it is a comment. You can use the help to see what each of the statements mean.
		4. Under the Compile menu, Select Compile, Save, and Send
		5. If everything is ok, you should not receive any error messages and if you have the CR1000KD plugged in, you can now check out the data.
		6. LIGTHLY blow on the sensor to see the response in terms of RH. Enclose the sensor GINGERLY in your hand to see a response to your body temperature.
		7. If for any reason, you can’t connect or the program does not compile, STOP and ask for help
4. **Modifying the Program**
	1. Declare two new variables and provide units where appropriate:
		1. Public AirTF
		2. Public Flag as BOOLEAN
		3. Units AirTF=Deg F
	2. *Question 5.* What does the 7 in the SDI12Recorder command mean? Hint: use the help.
	3. Add below the SDI… command: AirTF = AirTC\*1.8+32
	4. Select Compile, Save, and Send and verify that you are now recording air temperature in F
	5. *Question 6.* Why can’t you put in the multiplier 1.8 and offset 32 in the SDI12 command to get the temperature in F? Hint: what happens to the RH when you do? Yes, try it.
	6. We now want to have the RH control whether a control port is turned on. Put the red wire from the LED into C1 and the black wire from the LED into G.
	7. Add to the program beneath the SDI12 command the following
		1. ‘if rh > 50 then set flag true else false
		2. If RH>50 Then
		3. Flag = True
		4. Else
		5. Flag = False
		6. Endif
		7. ‘Turn LED connected to Port 1 on when Flag is True
		8. If Flag = True Then
		9. PortSet(1,true)
		10. Else
		11. PortSet(1,false)
		12. Endif
	8. Verify that the LED is not lit when the RH is <=50% and becomes lit when you breath on it.
5. **Further Modification of the Program**
	1. Use the integrated processing commands to compute dewpoint temperature in Celsius DWTC, saturation vapor pressure in **kPa** ES, and vapor pressure in **kPa** E. You will need to declare the variables, units, and sample them to put them into the CS215 data table.
	2. *Question 8.* Complete the following table for 1 set of observations with the vapor pressures in **hPa**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Time** | **Air Temp (C)** | **RH (%)** | **DWTC (C)** | **ES (hPa)** | **E (hPa)** |
|  |  |  |  |  |  |

1. **Final Steps**
	1. Create a lab report. This must be typed and submitted into canvas as a pdf file. Use the following template.

**Project Report. Laboratory Assignment 1. Due January 30. Must be submitted as a pdf into Canvas.**

**Your Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Group Member Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Restate the lab objective in your own words. Do not repeat verbatim.**

*Question 1.* The CS215 uses a single chip for both the temperature and RH sensor (the Sensirion SHT75- google that). Undergrads: how does the Sensirion measure temperature and relative humidity? (Graduate students only). Read the datasheet on the Sensirion sensor and describe in a paragraph or two briefly how it works.

*Question 2*. What’s the difference between the CrBasic commands ‘Sample’ , ‘Average’, and ‘Totalize’.

*Question 3.* Based on the manufacturer’s information complete the following:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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|  |  |  |  |  |  |

*Question 4.* How long does it take for the temperature sensor to increase by 0.95C when the environment experiences a 1C step temperature increase? Hint: go back to the info on time response from last week. What impact might the relatively slow time response of this sensor have on estimating the daily minimum or maximum temperature?

*Question 5*. What is the pore size of the cover in microns? How does that compare to the size of small particulates associated with air pollution that we often worry about? Will those small particles make it through the cover?

*Question 6.* What does the 7 in the SDI12Recorder command mean?

*Question 7.* Why can’t you put in the multiplier 1.8 and offset 32 in the SDI12 command to get the temperature in F?

*Question 8.* Complete the following table for 1 set of observations with the vapor pressures in **hPa**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Time** | **Air Temp (C)** | **RH (%)** | **DWTC (C)** | **ES (hPa)** | **E (hPa)** |
|  |  |  |  |  |  |

*Question 9*. When does it make sense to put in the bells and whistles (and when does it not make sense to do so)? That is, conditions such as using RH> 50% to turn on a control port or compute dewpoint and vapor pressure in the datalogger program vs. postprocessing the data once it is retrieved from the logger?

*Question 10 (graduate students only).* Explore on the web some of the applications of sensirion temperature/relative humidity sensors. Look for situations where they are being incorporated with microprocessors. Write a paragraph or two about those applications with links.